DESIGN AND ANALYSIS OF TRIPLE U TUBE HEAT EXCHANGER

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Abstract

The heat exchanger consists of triple tubes in various diameters. The tubes are located concentrically with U shape arrangement. Hot fluid enters through the inner and outer tubes in one direction and leaves at the end as cold fluid. The coolant flow to the middle tube in another direction This setup is used to calculate heat transfer on the tubes and effectiveness of the heat exchanger This arrangement is especially reduce the tube length and to increase the heat transfer area with reduction in the cooling time. This type of flow is to increase the effectiveness of the heat exchanger.

Keywords: *Triple U Tube Heat Exchanger, Heat Transfer, and Effectiveness*

Introduction

A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage treatment. Dawid Taler deals that General principles of mathematical modeling of steady-state and unsteady heat transfer in cross-flow tube heat exchangers with complex flow arrangements which allow to simulate multi pass heat exchangers with many tube rows were presented. Dawid Taler, Marcin Trojan, Jan Taler shows that Cross-flow tube heat exchangers find many applications in practice. An example of such an exchanger is a steam super heater, where the steam flows inside the tubes while heating flue gas flows across the tube bundles. J. Taler shows that the paper is to present two techniques for simply and accurately determining space-variable heat transfer coefficient, given measurements of temperature at some interior points in the body. Milind V. Rane, Madhukar S. Tanda shows that tube–tube heat exchanger (TTHE) is a low cost, vented double wall heat exchanger which increases reliability by avoiding mixing of fluids exchanging heat. It can be potentially used for heat recovery from engine cooling circuit, oil cooling, desuper heating in refrigeration and air conditioning, dairy, and pharmaceutical industry, chemical industry, refinery, etc. Current heat exchanger designs are extremely limited and have not experienced any major advancement in recent years. As described above, the main problem is that current heat exchanger experience a large resistance to heat transfer caused by air flowing over the heat exchanger. Current heat exchanger also experiences head resistance, are very bulky, and impose limitations on the design of the heat exchanger.

Methods for Design of Heat Exchangers

The LMTD method and the effectiveness-NTU method. The LMTD method is derived from the analytical method for calculating the performance of a parallel-flow heat exchanger. The product of overall heat transfer coefficient and the area is defined as the inverse of the overall thermal resistance of the heat exchanger. For heat exchangers other than parallel flow heat exchangers, the log-mean temperature difference does not perfectly describe the mean average temperature difference. For those other configurations, the formula is modified by multiplying the formula by a correction factor *F*. Correction factors for common heat exchanger configurations such as single and multi-pass heat exchangers.

Design Parameters for Outer Tube (Material: Mild Steel -K = 53.6 w/mk)

Table 1 Design Parameters for Outer Tube

Length of outer tube (L_o)	1.00 m
Diameter of outer tube (D_o)	0.040 m
Specific heat of hot fluid at outer tube (C_{pho})	4186J/kgK
Cross-sectional area of outer tube (A_{co})	$1.256 \times 10^{-3} m^2$
Surface area of outer tube (A_{so})	0.125 m^2
Mass flow rate of hot fluid at outer tube (M_{ho})	3 kg/s

Design Parameters for Middle Tube (Material: G.I Pipe K = 72 w/mk)

Table 2 Design Parameters for Middle Tube

Length of middle tube (L_m)	1.2 m
Diameter of middle tube (D_m)	0.025 m
Specific heat of cold fluid at middle tube (C_{pcm})	4186 J/kgK
Cross-sectional area of middle tube (A_{cm})	$4.9 \times 10^{-4} m^2$
Surface area of middle tube (A_{sm})	0.094m^2
Mass flow rate of hot fluid at middle tube (M_{cm})	1.5kg/s

Experimental Setup

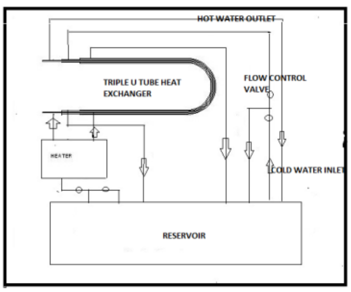

Figure 1 Experimental Set Up

Result and Discussion

The simulation results of triple U-tubes are shown in Figure. Since triple U-tubes have better thermal performance due to larger surface area for heat transfer and smaller thermal resistance, the total drilling depth is much shorter compared to single U-tube systems. In this case, the total drilling depth is 15% shorter if uses triple U D-25 instead of two U D-32. For the same category of tubes, using smaller diameter tubes will lead to larger drilling depth. For example, about 10% more drilling depth will be needed using triple U D-25 compared to double U D32. Thermal conductivity of the soil is another main factor that influences by using ansys software.

Thermal Gradient X

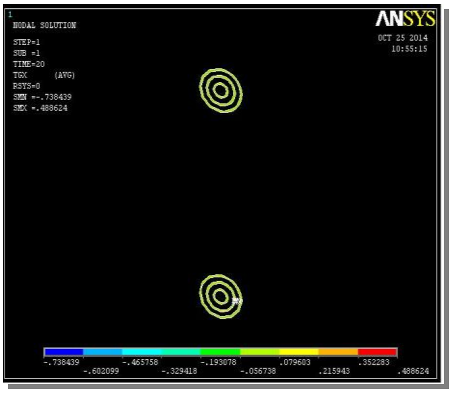

Figure 2 Image for Thermal Gradient X

Thermal Gradient Y

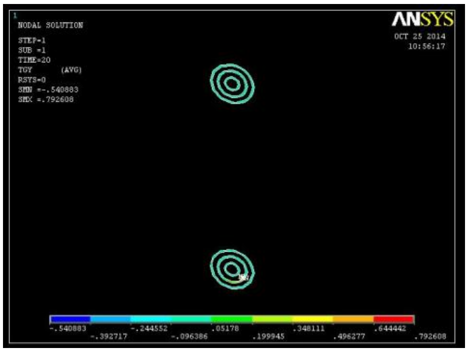

Figure 3 Image for Thermal Gradient Y

Thermal Gradient Vector Diagram

Figure 4 Image for Thermal Gradient Vector Diagram

Thermal Flux X

Figure 5 Image for Thermal Flux

Conclusion

In this experimental work the theoretical Design values of the triple U tube heat exchanger has been arrived. I conclude that heat increase as increase in surface Area of triple U tube heat exchanger with compact size. The new idea for Triple U tube heat exchanger is to increase heat transfer area and reduce the cooling time and achieve the effectiveness based on analysis with compact size. So, recommended to implement this new design compact size in thermal fields.

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